
CHAPTER 6.

ASSESSMENT OF POTENTIAL EFFECTS

EFFECTS OF SEASONAL LODGE ON LAND CULTURAL RESOURCES

The only land construction proposed for the Predevelopment, Ltd. Project consists of a seasonal lodge planned for the Building Envelope. This 0.4-acre (0.16 ha) segment is located at the far northern end of the Predevelopment, Ltd. property and lies 125 ft (38 m) landward of the OHWM for Lake Erie. This segment is forested with young trees and contains two small bedrock outcrops of smooth, flat-lying Columbus Limestone. Because the forested area does not contain older fallen trees or cavernous or broken bedrock, it does not possess any particularly advantageous habitats for the Lake Erie watersnake. The soils are well-drained and non-hydric in nature; thus this segment of the tract does not support the development of wetlands. The Phase I archaeological investigation of the Building Envelope indicated that prehistoric people (most likely Woodland Indians) may have used a portion of this segment to hunt for, test, and gather local and glacially derived chert for making tools, but no significant occupation or finished tool-making activities are likely to have taken place here.

The proposed seasonal lodge and appurtenances will occupy most of the Building Envelope. Disturbed areas of the BE surrounding these structures will be restored. Undisturbed areas of the BE will remain as woodlot, as well as the balance of the 6.1 acres (2.5 ha) of the Predevelopment, Ltd. tract outside of the BE. Because the area of disturbance is modest, and particularly since no important Lake Erie watersnake habitat, wetlands, alvars, or other sensitive habitats are likely to be disrupted, the proposed seasonal lodge is not expected to have any significant adverse environmental effects.

Likewise, construction of the seasonal lodge is not anticipated to have any adverse effect on cultural resources of Long Point or adjacent areas of Kelleys Island. This assessment is based on the absence of any prehistoric tools or other significant artifacts in the Building Envelope as revealed from a relatively dense sampling pattern and from other cultural resource

investigations in the vicinity (Krebs 1980, Grooms and Bergman 2001) which had similar results.

The Predevelopment, Ltd. property, does however possess several important historical features, including the Lincoln House foundation and cisterns (33ER521), and the Lincoln Stone Wall (ERI-1664). Special care needs to be taken in the movement of construction equipment and materials to the Building Envelope and to the location of the boat docking facility. The existing private access drive (Long Point Lane) passes very close to the Lincoln House foundation and one of the cisterns, thus there is a risk of disturbance unless appropriate precautions are taken to protect the sites. Given that such precautions are in place, construction can be successfully completed without adverse effects to the historic sites.

EFFECTS OF BOAT DOCKING FACILITY ON SUBMERGED CULTURAL RESOURCES

The Predevelopment, Ltd. Project includes construction of a boat docking facility for 8 to 10 recreational watercraft. The facility will project lakeward 150 ft (45 m) and extend linearly 200 ft (60 m) parallel to the shoreline. The construction will be similar to other recently built docking facilities on the shore of Kelleys Island (e.g. at Camp Patmos also on Long Point, Figure 6-1), in that it will provide maximum habitat for the federally threatened Lake Erie watersnake.

The results chapter of this report documents the presence of 2 historic shipwrecks, steambarge *ADVENTURE* (33ER481) and scow schooner *W. R. HANNA* (33ER488) less than 300 ft (90 m) offshore of the Predevelopment, Ltd. property on the northwest shore of Long Point. Thus, the following discussion addresses the results of an analysis of the anticipated effect the proposed docking facility will have on the historic shipwrecks.

COASTAL PROCESSES

All structures constructed from the shore that stick out into Lake Erie tend to alter incoming waves



Figure 6-1. Camp Patmos boat docking facility located on Long Point, Kelleys Island; the design of this docking facility is similar to the one proposed for the Predevelopment, Ltd. Project (June 3, 2004).

and modify associated coastal processes, such as alongshore currents and littoral drift. These alterations can be beneficial, detrimental, or neutral to the adjacent coast and any submerged cultural resources in the vicinity of the structure. To assess the potential effects of the proposed Predevelopment, Ltd. boat docking facility on the adjacent shoreline, and particularly the historic shipwreck sites, an analysis of the wave climate in North Bay was undertaken.

In 1958 the Ohio Department of Natural Resources, Division of Shore Erosion conducted a study of the North Bay of Kelleys Island preparatory to construction of a small boat harbor in North Pond by the State of Ohio (Hartley and Verber 1960). As part of this study wind conditions for the north shore of Kelleys Island were analyzed in terms of their wave-generating potential. This analysis showed that southwest winds prevail and dominate during the year, however, these winds do not generate sizeable waves in North Bay. Winds occurring 2nd through 5th in

number of days per year move clockwise in order of importance: west, northwest, northeast, and east. Winds from the north are rare. Considering that North Bay has a recreational boating season of six months (May-October), the study showed that during this period only 12 days of northwesterly and northeasterly winds and waves would make the harbor unsafe to enter. About 52 days (28% of the time) moderate winds and waves occur from these directions, but would not prevent the use of the harbor.

The Waterways Experiment Station of the U.S. Army Corps of Engineers conducted a 32-year wave hindcast study of 53 stations on Lake Erie for the period 1956-1987 (Driver et al. 1991). The summary of data from Station 3, located in the Bass Islands area and the nearest one to Kelleys Island, is on the wave rose diagram in Figure 6-2. This diagram shows that northwest, north, and northeast waves are active 12, 7, and 10% of the time respectively. These would be the directions that would most affect North Bay conditions.

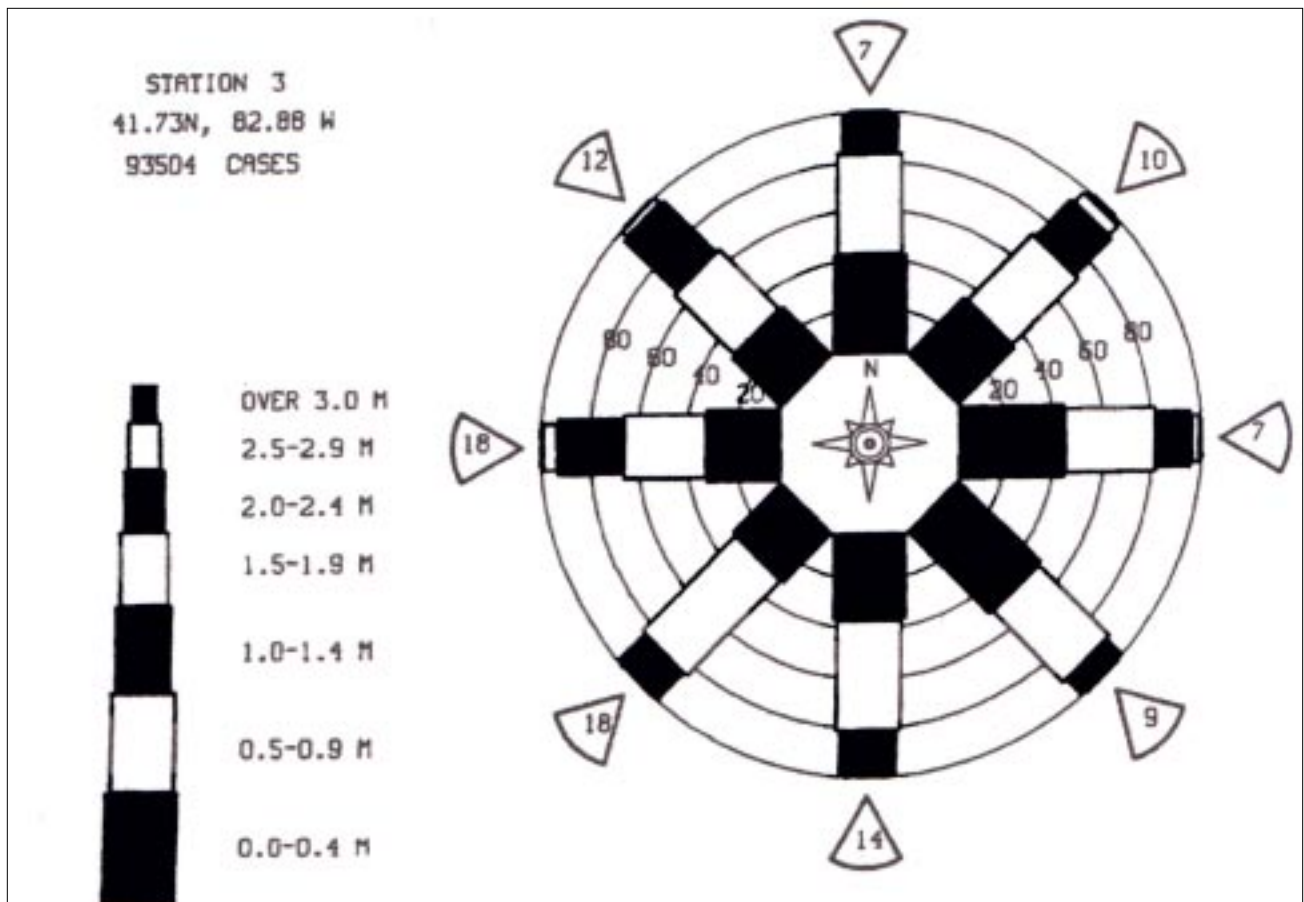


Figure 6-2. Wave rose diagram of hindcast predictions of wave directions and heights for the Lake Erie islands, showing dominant northwest and northeast waves entering North Bay (after Driver et al. 1991).

The width of the bars indicates the wave heights that can be expected for the percentage of time given for each direction. On average, waves from these directions have heights of nil to 0.4 m about 40% of the time and collectively these directions account for 29% of the time. Thus, waves greater than 0.5 m are hindcast to occur only 17% of the ice-free period of the year.

More recent observations for the ice-free period of the year (March to November) at the NOAA weather buoy about 15 mi (24 km) east of Kelleys Island show that waves average less than 1 m in height about 70% of the time. On a monthly basis at the buoy, 1 m or less waves can be expected with the following frequency (Bolsenga and Herdendorf 1993:207-214):

Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
58	72	75	83	82	72	51	50	45%

Waves 2 m in height or greater rarely occur in western Lake Erie; at the NOAA weather buoy, wave heights of this magnitude occur less than 2% of the time in spring, less than 1% in the summer, and less than 5% in the fall.

Wave periods (the time required for the crests of two successive wave crests to pass a fixed point) typically range from 4 to 8 seconds in the spring, 3 to 6 seconds in the summer, and 4 to 8 seconds in the fall. Wavelength (distance between two successive wave crests) and wave period are related as shown in the following formula:

$$L = \frac{gT^2}{2\pi}$$

where L = wave length in meters, g = acceleration due to gravity (9.8 ms⁻²), and T = period in seconds. Thus for the typical wave periods recorded for western Lake Erie, the following relationship exists:

Period (sec)	Wavelength (m)
3	14.0
4	30.0
5	39.0
6	56.2
7	74.5
8	99.9

Bolsenga and Herdendorf (1993:214) found that wavelengths of less than 20 m occur about 50% of the time in western Lake Erie.

An important consideration in terms of wavelength is the transformation as waves progress from deepwater (as measured at the NOAA buoy) to shallow water in the vicinity of the proposed boat dock. As waves approach the shore, at a depth of one half of the wave length the lake bottom begins to interfere with the wave form causing the waves to “peak up” and eventually break. For a typical (mean) wave with a 20-m wave length (and for longer wave lengths) this initial distortion would take place offshore in water depths of 10 m, approximately 1 km to the northwest through northeast of the proposed dock.

As waves continue to progress toward the shore, at depths of about $\frac{1}{20}$ their length, they begin to collapse in a process known as breaking and the energy derived from the wind is dissipated on the lakeshore and bottom. For a mean wavelength, breaking occurs in water about 1 meter deep, generally a distance of 20 m offshore.

The northwest shoreline of Long Point typically exhibits spilling-type breaking waves. Spilling breakers are characterized by foam and turbulence at the wave crest. The spilling usually starts some distance from shore and is caused when a layer of water at the crest moves forward faster than the wave as a whole (due to bottom interaction). Such waves are characteristic of a gently sloping shoreline as found at Long Point. During a storm spilling breakers reach the shore, when the waves are steep and short. They dissipate their energy gradually as their top spills down the front of the crest. This gives a violent appearance to the lake because of the prolonged period of breaking.

Small gentle waves and swells tend to build up beaches, whereas storm waves tend to tear them down. Storms are usually attended by higher water levels which tend to advance the breaking waves farther shoreward. The effect of storm waves on both shorelines of Long Point are evident in the massive storm ridges and berms built up from limestone rubble derived from the lakeshore. The northwest ridge appears to have been constructed by northwest storms, whereas the easterly shore ridges are likely the result of northeast storms.

Other important considerations for nearshore waters are wave diffraction, refraction, and reflection. Diffraction is the bending or spreading out of water waves around objects such that energy is transmitted behind a barrier (similar to the way sound waves travel

around a wall from one room to another). As a water wave passes a barrier, some of the energy is transmitted along the wave, producing smaller waves behind the barrier (Davis 1987:100-103). This occurs in places with protruding headlands along the coast (such as Long Point), or man-made structures such as breakwaters, jetties, and docks. The general distribution of the energy that results from wave diffraction is in the form of a parabola, with the apex at the feature that created diffraction. The energy in the parabola (or shadow zone) is significantly reduced from that in the generating wave (Van Dorn 1974:183). For example, a 1-m wave from the east to northeast quadrant would result in a wave height of approximately 0.1 m at the proposed dock facility. Likewise the dock facility will create an additional energy shadow in the vicinity of the *ADVENTURE* and *W. R. HANNA* shipwrecks (Figure 6-3). Interestingly, the shipwrecks themselves will provide some diffraction of west to northwest waves, providing a shadow zone for the proposed docking facility.

Refraction of waves is the bending of wave fronts due to the effect of shallow water and how it impedes the segment of the front that first encounters the shoal water. When one part of the wave reaches a shallower depth before another, the part impeded is slowed

relative to the other and the wave front is bent in the direction of the shoal. The refraction of waves causes energy to be dispersed or concentrated depending on the configuration of the shore and bottom contours. Headlands typically have a concentration of wave energy, while coves and embayments disperse wave energy (Figure 6-4). The proposed boat docking facility is positioned near the center of the embayment along the northwest shore of Long Point (Figure 2-5). This location is advantageous in that refraction of waves approaching from the northwest (direction of the maximum open water fetch and a common storm direction) will be concentrated on the headland north of the facility while wave energy at the facility will be dispersed.

When waves approach the shore at an angle, refraction occurs and alongshore currents are generated. The bending of the waves tends to pile up excess water along the shore, which escapes parallel to the shore away from the incoming wave crests (Figure 6-5). These currents are one of the primary factors in sediment transport long the coast. As waves break near the shore, they cause a large amount of sandy sediment to be thrown into suspension that is then carried alongshore by these currents. Such currents generated by storm conditions can travel at velocities

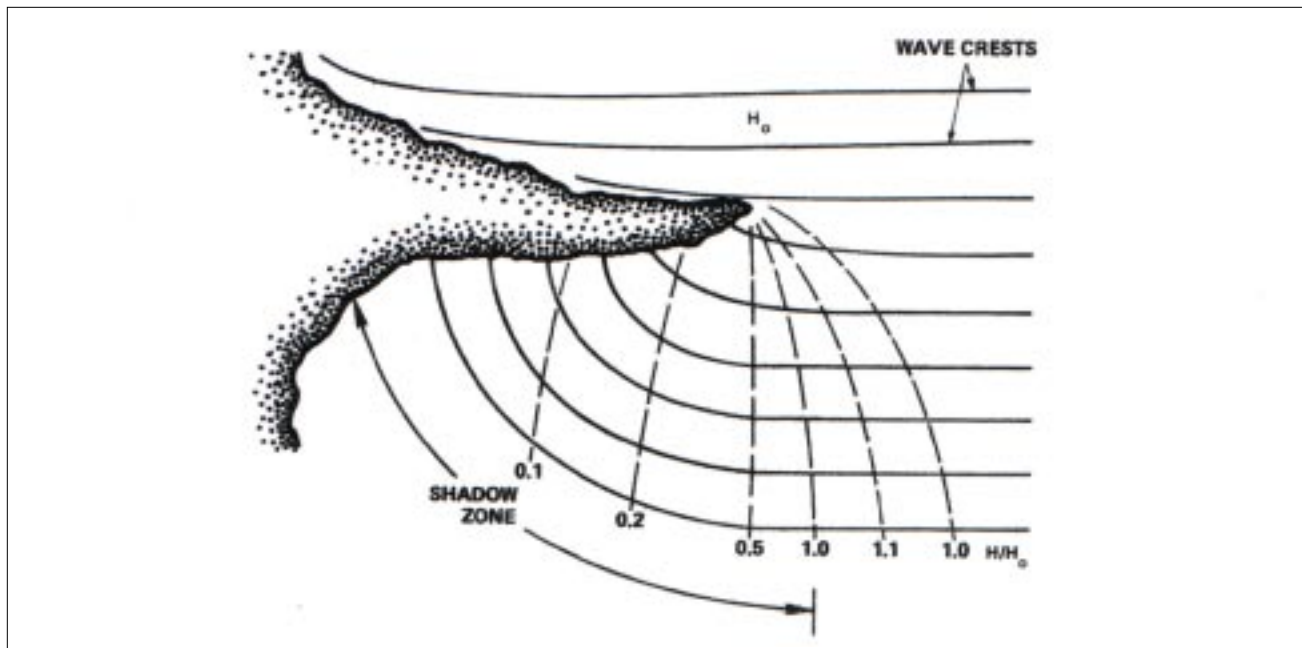


Figure 6-3. Diagram illustrating the diffraction of waves into the shadow zone behind a headland. The numbers give the ratio of the incoming offshore wave height $[H]$ to the wave height produced in the shadow zone $[H_o]$ (after Van Dorn 1974:183).

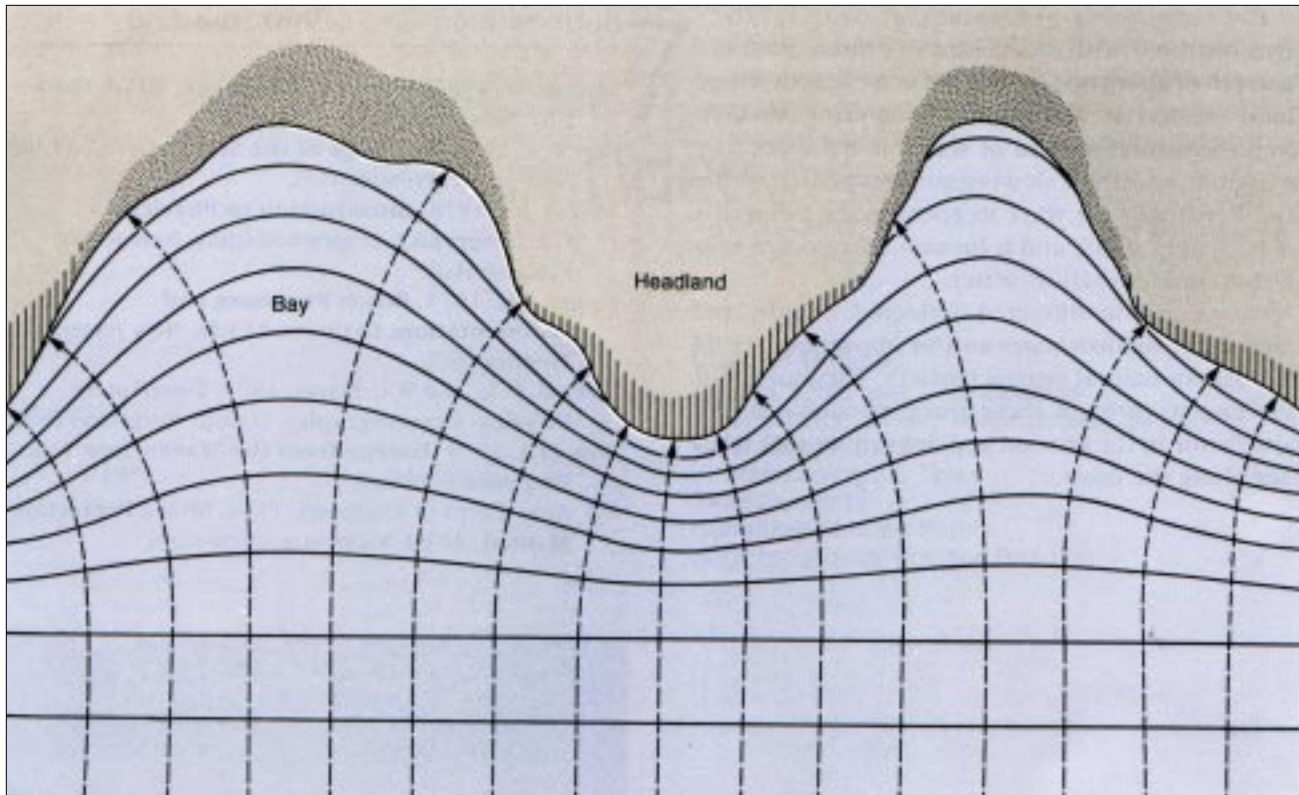


Figure 6-4. Diagram illustrating how wave refraction tends to either concentrate or disperse wave energy. The dashed lines, known as orthogonals, are lines perpendicular to the wave crests with equal amounts of energy. Bending of orthogonals demonstrates the convergence or divergence of wave forces (after Davis 1987:103).

greater than 1m/sec, thus carrying large quantities of sediments. Velocities of this magnitude are capable of transporting particles as large as 4-10 mm diameter pebbles (Figures 6-6 and 6-7) as demonstrated by Hjulström (1935:298).

Waves that meet vertical walls such as steep cliffs, seawalls, jetties, and similar structures are reflected with little loss of energy. Incoming waves with crests parallel to the reflecting surface may form standing waves, which move up and down, but do not progress horizontally. This occurs when the reflected wave is reinforced by the next incoming wave. Commonly, however, waves approach the vertical barrier at an angle and are reflected at the same angle (Figure 6-8) according to Snell's Law (angle of reflection is equal to the angle of incidence). Beaches also present barriers to wave progression and reflect wave energy, however, most of the energy is dissipated or absorbed by the beach so that the percentage of energy that is reflected is low (Davis 1987:102). For sandy beaches the amount of energy reflected is proportional to the steepness of the beach, whereas, for gravel beaches there is a

tendency to absorb rather than reflect wave energy because their coarse particles allow water to percolate into the beach so that little is reflected. The proposed boat dock facility utilizes this principal in two ways. Firstly, the vertical wall steel cribs will be filled with angular limestone rubble, which will absorb a significant portion of the incoming wave energy. Secondly, the installation of the rock jetty at the southerly shore end of the facility will further absorb wave energy and help prevent standing waves, surges, and oscillations within the south shore of the facility. These measures will also tend to minimize wave reflection in the vicinity of the shipwrecks.

In conjunction with a planned harbor of refuge in the North Bay of Kelleys Island, the U.S. Army Corps of Engineers Waterways Experiment Station (Wilson and Hudson 1963) conducted an analysis of waves that could potentially effect the stability and utility of such a harbor. The analysis produced a table of estimated durations of waves of various heights and periods for nine directions (22.5° increments) of approach from the west through north to east (Table 6-1).

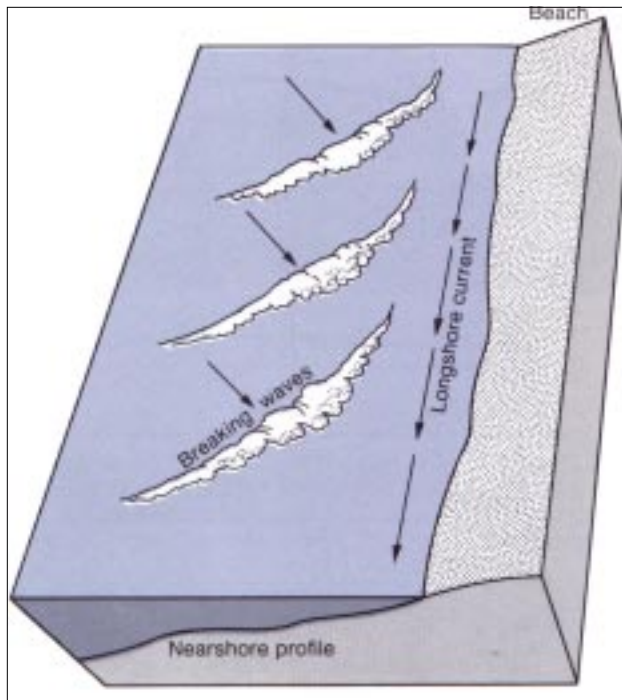


Figure 6-5. Diagram illustrating how waves approaching the shore at an angle are refracted as the shallow bottom interferes with their progress. The excess water concentrated at the shore then generates an alongshore current away from the incoming wave front (after Davis 1987:102).

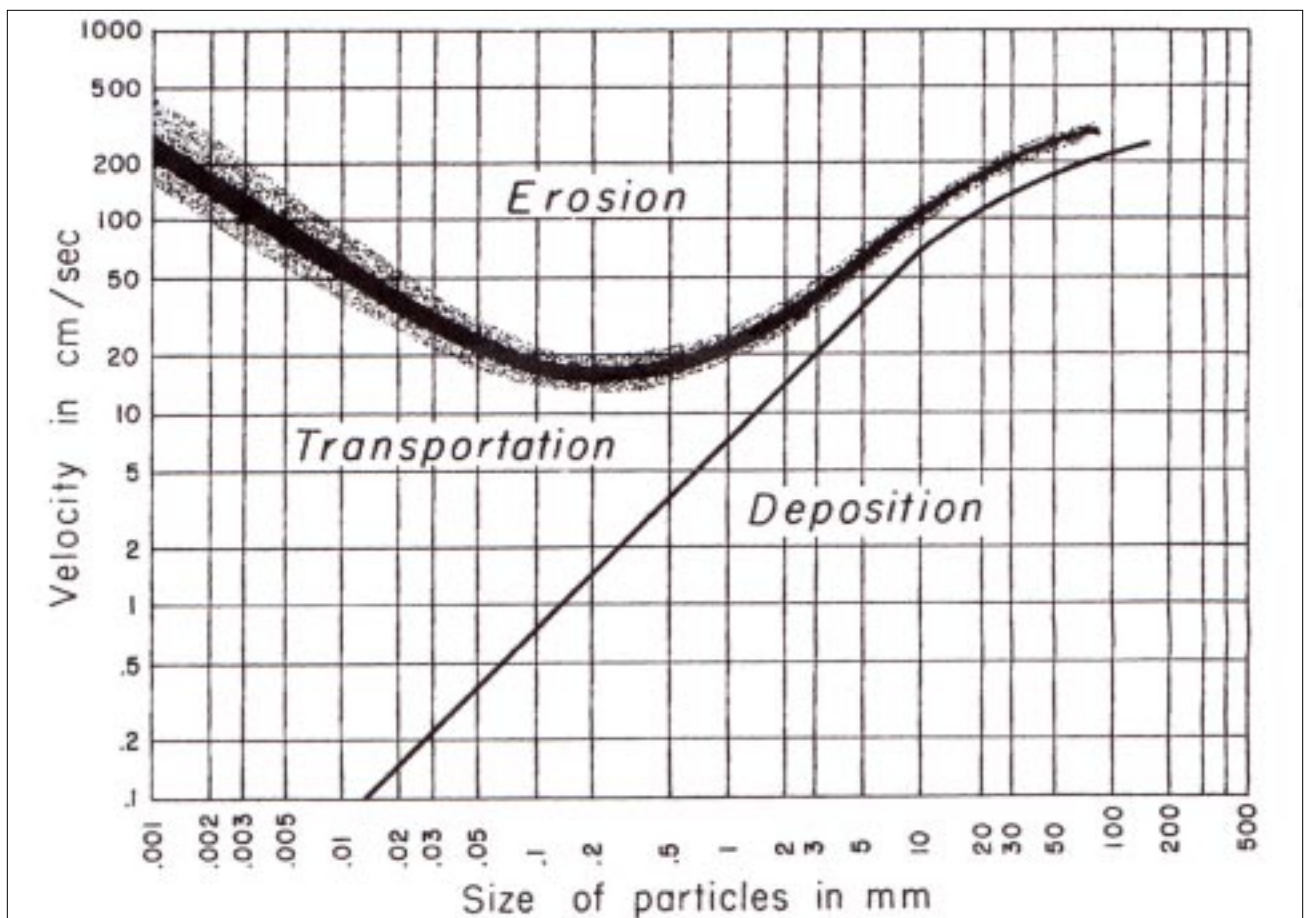


Figure 6-6. Graph showing the velocities at which different size grades of sediment will be eroded, transported, or deposited (after Hjulström 1935:298).

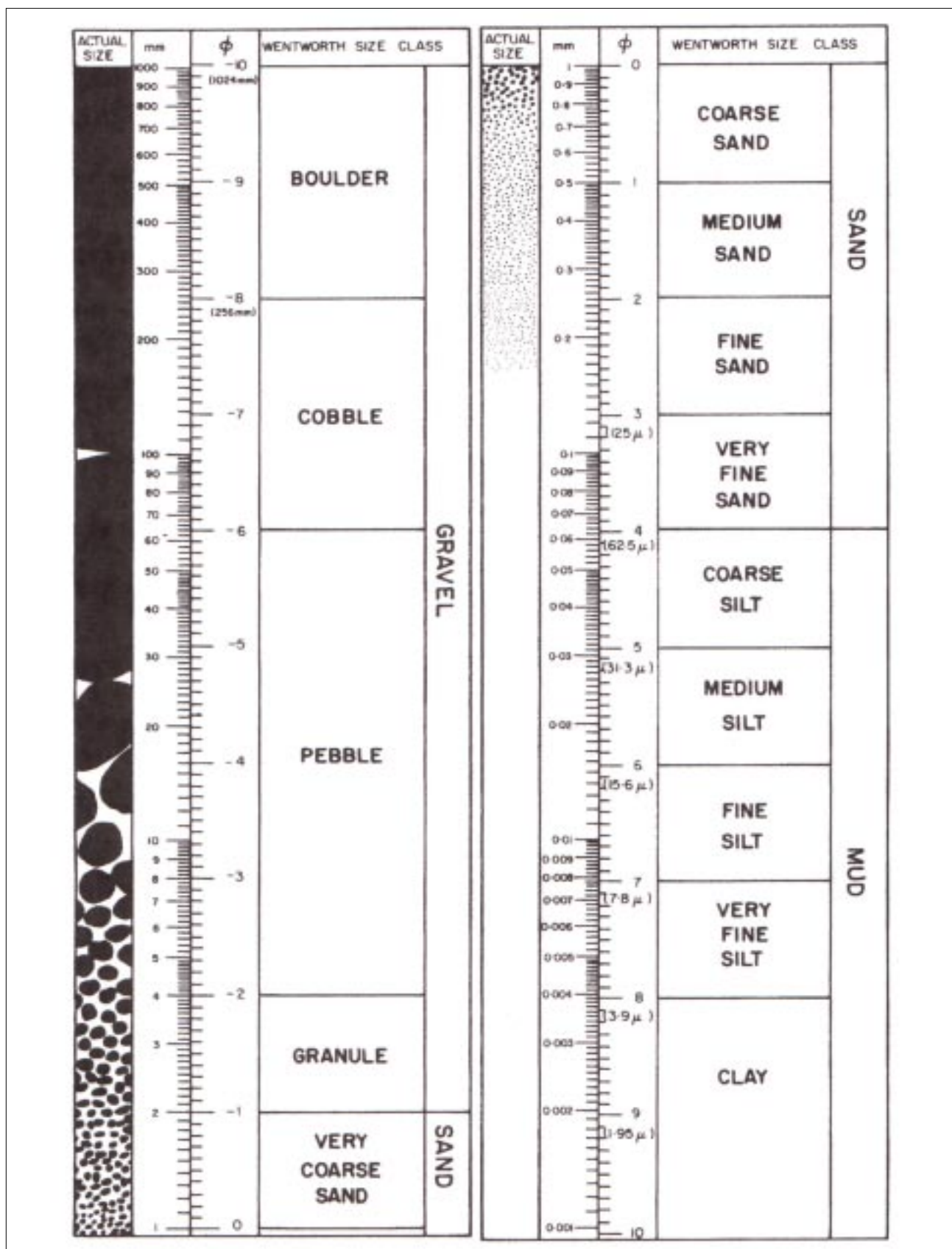


Figure 6-7. Udden-Wentworth sediment grain-size scale (after Lewis 1984:59).

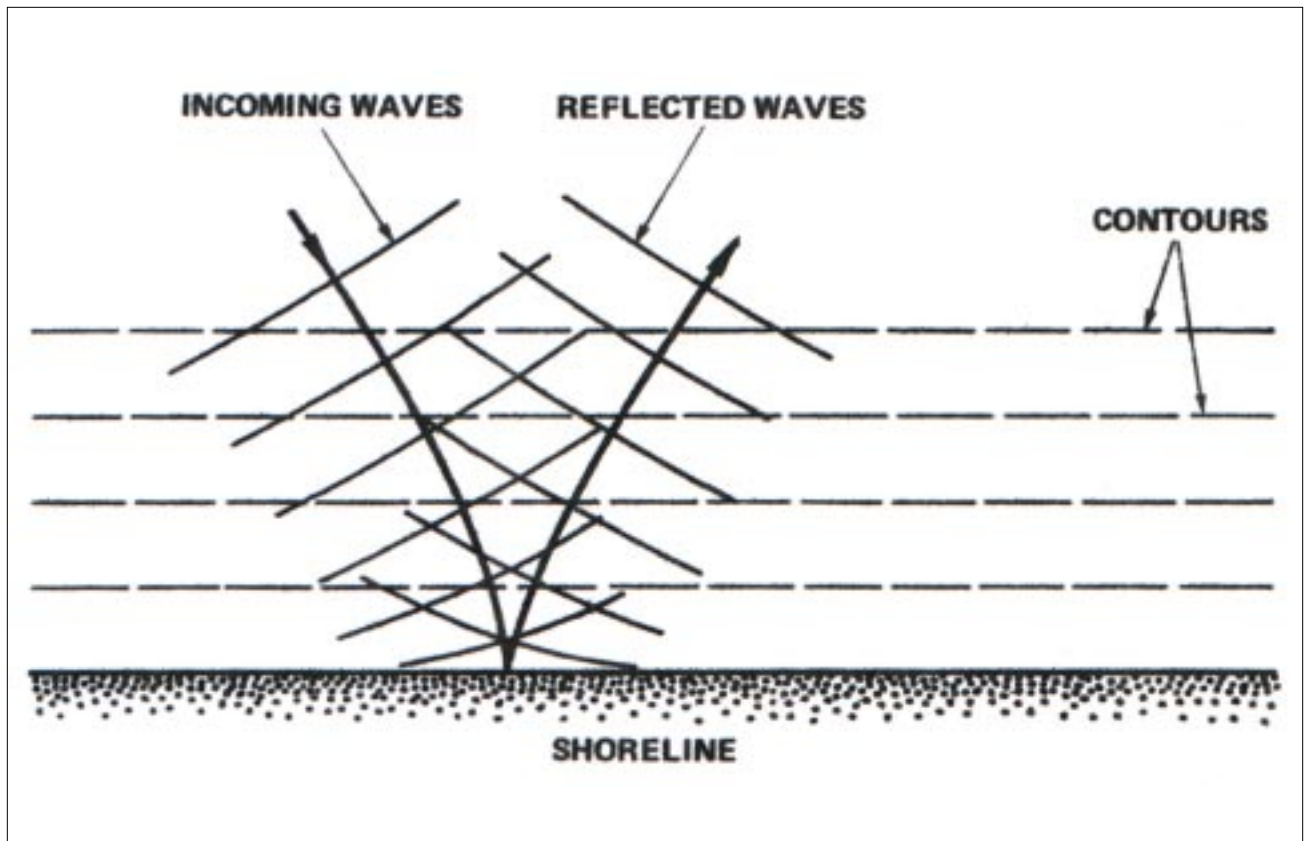


Figure 6-8. Diagram of waves approaching a cliffed shore at an angle, illustrating how they are first refracted, then reflected, and finally refracted again in the opposite direction (after Van Dorn 1974:182).

The Corps of Engineer's analysis showed that as waves moved into water of gradually decreasing depth within North Bay, important transformations took place in all of the wave characteristics except wave period. Waves that were approaching the shoreline at an angle were bent (refracted), because the inshore portion of the wave front traveled at a lower celerity (speed) than did the adjacent portion in deep water; consequently the wave front was bent and tended to become parallel to the bottom contours. Thus, refraction caused changes in wave height, wavelength, and direction of wave fronts. Insofar as exposure of the North Bay shoreline to severe storms, wave refraction diagrams showed that north northwest waves are potentially the worst. However, frequency of occurrence of storms from this direction is relatively low and fortunately, due to the bathymetry there is a dispersion of wave energy resulting from refraction as the waves enter the bay (Figures 6-9 and 6-10). The spreading of the orthogonals within North Bay indicates a lessening of wave energy toward Long Point. As a result of wave refraction analysis, the deepwater waves approaching

North Bay (as shown in Table 6-1, were transformed. The waves predicted to actually reach the shoreline are shown in Table 6-2. A comparison of these two tables clearly shows that storm wave heights are greatly reduced or eliminated as waves pass through North Bay.

As the result of this analysis, the U.S. Army Corps of Engineers (Wilson and Hudson 1963:22) concluded that waves approaching the shore will be refracted and considerably reduced in height due to the influence of the lake bottom. The study also found that waves reaching the shore from westerly directions will be insignificant due to short offshore fetch and that northeasterly waves will also be insignificant because of the barrier presented by Long Point. The maximum waves to reach the shore will be 5 to 6 ft in height and such waves will have a duration of less than 12 hours per year.

**TABLE 6-1. ESTIMATED DURATION OF STORM WAVES APPROACHING
NORTH BAY OF KELLEYS ISLAND**

Approach Direction	Wave Height	Duration of waves (hr/yr)				
	(ft)	2-3 sec	3-4 sec	4-5 sec	5-6 sec	6-7 sec
WEST (270°)	<1	2				
	1-2		94			
	2-3		226			
	3-4			42		
	4-5			12	4	
WEST NORTHWEST (292.5°)	<1	412				
	1-2	104				
	2-3		30			
	3-4		4			
NORTHWEST (315°)	<1	336				
	1-2	28				
	2-3		40			
NORTH NORTHWEST (337.5°)	<1	28				
	1-2		258			
	2-3		56	2		
	3-4			26		
	4-5					
	5-6				2	
	6-7				2	
	7-8					
	8-9					2
NORTH (0°)	<1	58				
	1-2	156	130			
	2-3		26	4		
	3-4			14		
NORTH NORTHEAST (22.5°)	<1	42				
	1-2	2	332			
	2-3		94			
	3-4			22		
NORTHEAST (45°)	<1	16				
	1-2		70			
	2-3		30	102		
	3-4				52	
	4-5				14	
	5-6					6
EAST NORTHEAST (67.5°)	<1		56			
	1-2		182			
	2-3			54		
	3-4			26		
	4-5				12	

TABLE 6-1. ESTIMATED DURATION OF STORM WAVES APPROACHING NORTH BAY OF KELLEYS ISLAND (CONTINUED)

Approach Direction	Wave Height (ft)	Duration of waves (hr/yr)				
		2-3 sec	3-4 sec	4-5 sec	5-6 sec	6-7 sec
EAST (90°)	<1		66			
	1-2		176			
	2-3		24	60		
	3-4			8	20	
	4-5				36	
	5-6				2	8
	6-7					2

TABLE 6-2. ESTIMATED DURATION OF TRANSFORMED STORM WAVES REACHING THE NORTH BAY SHORE

Approach Direction	Wave Height (ft)	Duration of waves (hr/yr)				
		2-3 sec	3-4 sec	4-5 sec	5-6 sec	6-7 sec
NORTHWEST (315°)	0.5-1	364	10			
	1-2		30			
NORTH NORTHWEST (337.5°)	0.5	28				
	1-2		300	8		
	2-3		14	20		
	3-4				2	2
	4-5				2	
NORTH (0°)	0.5-1	58				
	1-2	156	130			
	2-3		26	8		
	3-4			10		
NORTH NORTHEAST (22.5°)	0.5-1	42				
	1-2	2	332			
	2-3		94			
	3-4			11		
	4-5			11		
NORTHEAST (45°)	0.5-1	16	18			
	1-2		60	26		4
	2-3		22	76		
	3-4				13	
	4-5				43	
	5-6				10	2

Note:

Waves transformed and refracted from approach directions given in Table 6-1, resulting in the elimination of waves from the west, west northwest, east northeast, and east at the shore.

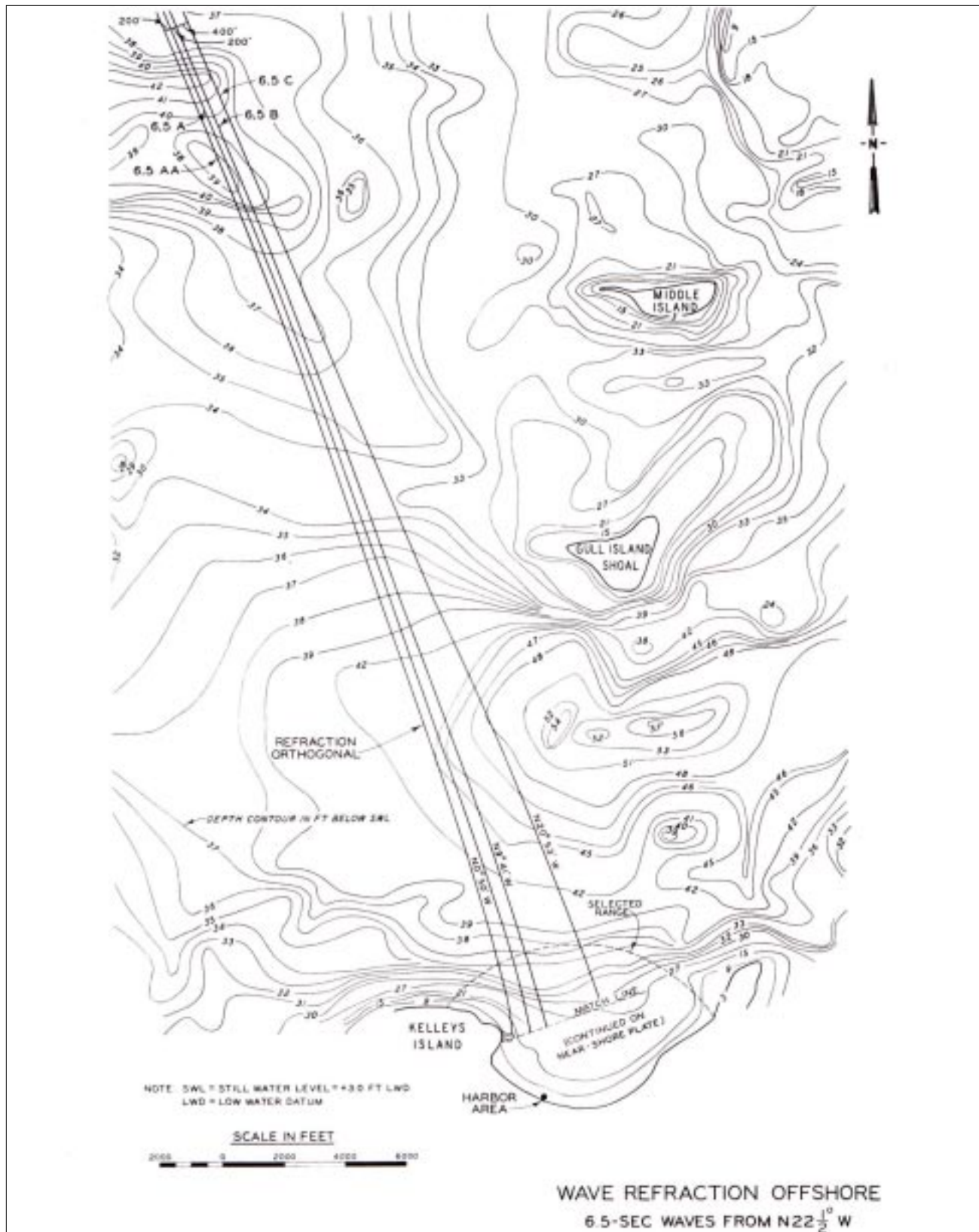


Figure 6-9. Map showing offshore refraction of north northwest waves approaching North Bay of Kelleys Island (after Wilson and Hudson 1963:plate 2).

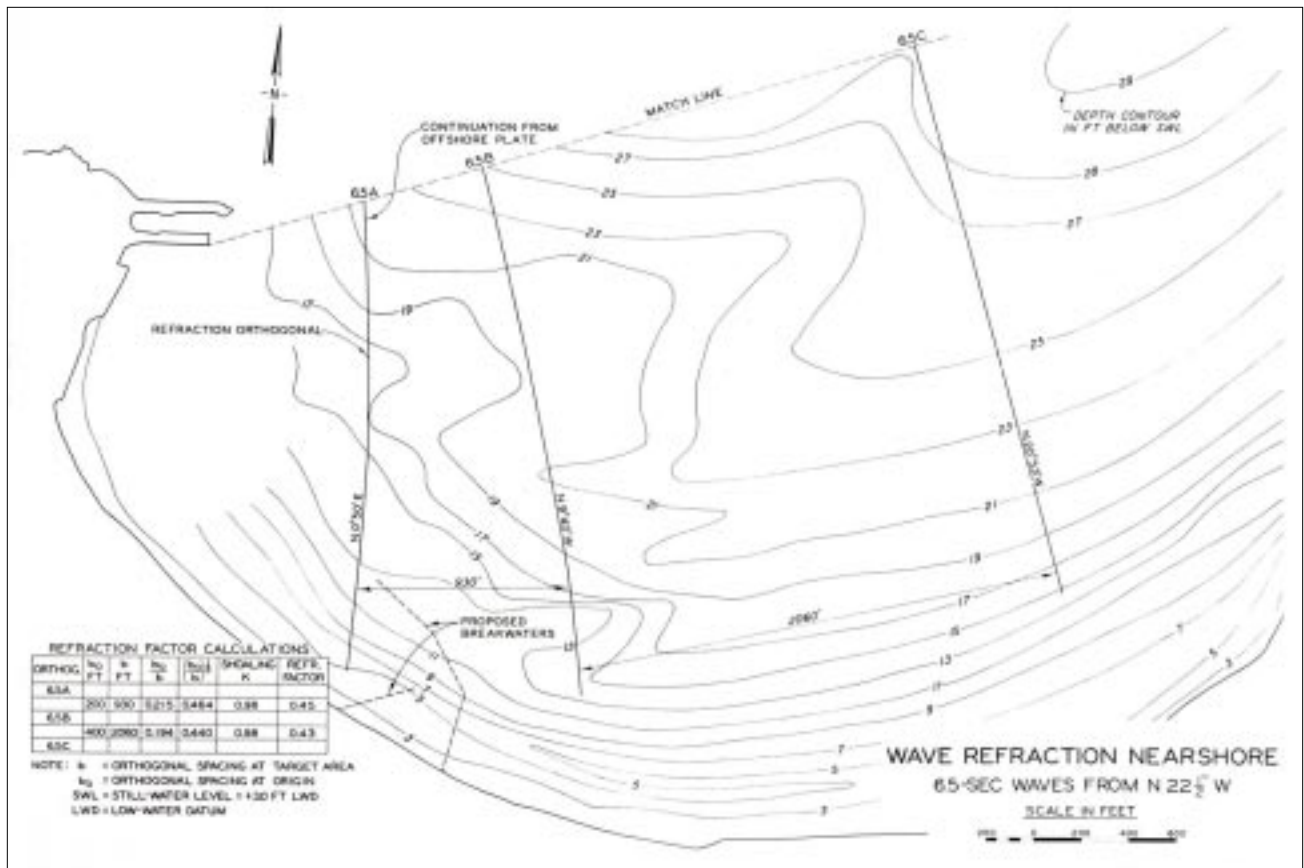


Figure 6-10. Map showing nearshore refraction of north northwest waves within North Bay of Kelleys Island; note spreading of energy orthogonals toward Long Point (after Wilson and Hudson 1963:plate 3).

COMPARISON WITH EXISTING DOCKING FACILITY

The proposed boat docking facility is very similar to an existing docking facility on Long Point at Camp Patmos (Figure 6-1), about 2,200 ft (670 m) southwest of the Predevelopment, Ltd. site. The Camp Patmos facility does not appear to have adversely effected the shoreline or nearshore (littoral) processes, but it does provide some “wave shadow” protection to the adjacent shore. Some accumulation of sand may also be taking place on the updrift side of the dock cribs, further protecting the shoreline. The Predevelopment, Ltd. facility is expected to function in a similar manner, but because the sand bed narrows to the northwest, accumulation of sand on the updrift cribs is not anticipated.

RECREATIONAL DIVER SAFETY

The shipwrecks of the *ADVENTURE* and *W. R. HANNA* are popular recreational dive destinations in western Lake Erie (Herdendorf et al. 2002). In addition

to casual use by sport divers, these historic shipwreck sites are used as underwater archaeological training features for undergraduate and graduate-level university courses. Also, the Ohio Sea Grant College Program at The Ohio State University annually sponsors “Sea Camp,” a program for elementary and middle school students at the 4-H Camp on Kelleys Island that includes snorkeling classes on the historic shipwrecks. Given this level of interest and activity in the shipwrecks, the construction of a boat docking facility in close proximity must be considered carefully.

Because the proposed boat docking facility is less than 300 ft (90 m) from the 2 submerged shipwrecks (Plate 1), the potential exists for a conflict between SCUBA divers and snorkelers exploring the shipwrecks and vessels attempting to enter or depart the boat docking facility. Ohio law (O.R.C. 1547.08) prohibits a boat from navigating within 300 ft (90 m) of an official diver’s flag unless the vessel is tendering the diving operation.

The potential conflict can be minimized by the placement of a close-spaced set of channel markers leading from the dock entrance to the open lake that gives reasonable clearance of the shipwrecks and any divers that may be on the wrecks. A buoyed channel—with appropriate signage to alert boaters of the potential of shipwrecks south of the channel—would not only provide safety for the divers, it would also protect the shipwrecks from potential striking by a vessel as well as protecting passing vessels from colliding with a submerged object, such as the propeller of the *ADVENTURE*, which is relatively shallow.

SUMMARY

In summary, the potential for temporary disturbances and long-term adverse effects to land-based and submerged cultural resources of the Long Point area, Kelleys Island, Ohio from the proposed Predevelopment, Ltd. Project are considered in this assessment. The construction of a seasonal lodge on the property will pose a minimal risk of disturbance. The location planned for the lodge is as remote as possible from documented historic resources and no significant prehistoric resources were discovered at the building site. Precautionary measures have been recommended to further reduce this risk.

No submerged cultural resources were discovered in this investigation, thus the disturbance of unknown cultural resources is not anticipated during the construction of the docking facility. However, 2 known historic shipwrecks, the steambarge *ADVENTURE* (33ER481) and the scow schooner *W. R. HANNA* (33ER488), lie less than 300 ft (90 m) southwest of the docking facility site and this situation was given special consideration. Several potential risks to these historic sites are associated with the construction and operation of the docking facility. These include: (1) damage to the shipwrecks by construction vessels and barges and the inadvertent placement of construction materials on the historic sites, (2) sedimentation on the historic sites related to construction activities, (3) modifications of coastal processes and wave action to the detriment of the historic sites, (4) operation of recreational watercraft associated with the docking facility which may adversely effect the historic sites, and (5) safety of divers on the historic sites.

Marker buoys placed at the extremities of the historic features, such as the bow, stern, and disjointed stem of the *ADVENTURE* and the bow and stern of

the *W. R. HANNA*, during the construction phase of the project will minimize the potential for a collision between the work vessels and the historic shipwrecks, as well as, the possibility of placing materials on the historic sites. With modern locational equipment the risk of drifting over the shipwreck sites, is small, but special precautions must be observed during heavy sea conditions, especially with strong winds from the east and northeast which could induce drifting toward the shipwrecks.

The bottom at the construction site consists of firm materials (Figure 2-6), including bedrock, boulders, cobbles, and sand. These are non-flocculent sediments, and do not contain any significant amounts of clay- and silt-sized particles which would be the type associated with causing turbid conditions and unwanted sedimentation of the shipwreck sites. Thus, using care in the seating of the dock facility cribs should minimize the risk of sedimentation on the site. The outer wall of the cribs will be set in sand, which if disturbed, would typically settle to the bottom within a short distance of its original location. Construction during more or less quiescent conditions will further reduce the risk of sediment disruption and transport.

Analysis of waves and associated coastal processes indicated that incoming “deep water” waves are significantly attenuated in their passage through North Bay. During the boating season wave conditions unsafe for recreational watercraft only occur approximately 7% of the time. The proposed site for the docking facility is the most favorable location along the Predevelopment, Ltd. shore, in terms of wave conditions, with much of the wave energy from northwest storms being refracted toward the headland north of the site. The docking facility is expected to provide some “shadow zone” protection to the shipwrecks from northeast storms. Because of the irregular surfaces of the stone-filled dock cribs, wave reflection will not occur to the detriment of the shipwrecks.

Proper operation of recreational watercraft entering and departing the docking facility so as not to induce wakes, collide with submerged cultural resources, or jeopardize recreational diver safety is a major concern. Recommendations have been given to minimize these risks to an acceptable level so that both these activities can safely coexist in a relatively confined space.